

09/978041

TITLE OF THE INVENTION

**LAMELLA OF A HEADBOX OF A PAPER, CARDBOARD, OR
TISSUE MACHINE**

INVENTORS

**Wolfgang RUF
Hans LOSER**

P21325.S03

09/978041

P21325.S03

**LAMELLA OF A HEADBOX OF A PAPER, CARDBOARD, OR
TISSUE MACHINE**

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] The present application claims priority under 35 U.S.C. § 119 of German Patent Application No. 100 51 802.2, filed on October 18, 2000, the disclosure of which is expressly incorporated by reference herein in its entirety.

BACKGROUND OF THE INVENTION

1. **Field of the Invention**

[0002] The present invention relates to a lamella of a headbox in, e.g., a paper, cardboard or tissue machine.

2. **Discussion of Background Information**

[0003] A lamella of a multi-layered headbox is known to the Applicant from European Patent Application No. EP 0 681 057 A2. In the nozzle of the disclosed headbox, at least one lamella is provided, which maintains the distance of two adjacent suspension flows down to a region of an exit nip. The lamella is formed of plastic with its modulus of elasticity preferably being smaller than about 80,000 N/mm².

[0004] As is generally known, the plastic can be a polycarbonate (PC) which has been extremely successful as a material for many modern and technically demanding applications due to its specific characteristics. For example, the high-tech polycarbonate by the company Bayer AG with the trade name Makrolon®, and that of General Electric with the trade name Lexan®, have a global reputation.

[0005] The polycarbonate is used for inexpensive lamellae of applications in which the use of expensive lamellae is impossible or not suitable for economic reasons, e.g., in one-layered headboxes in which the lamellae end within the nozzle.

[0006] When polycarbonate is used as the material for lamellae, it is

disadvantageous that the connection between the lamella and the headbox (or turbulence generator) must be constructed larger than sometimes desired due to the low stability of the polycarbonate. Additionally, polycarbonate has mechanical, chemical, thermal, and processing disadvantages as well.

[0007] Carbon fiber composite materials are better, yet also more expensive materials for lamellae, by which lamellae are produced in several components. The carbon fiber composite materials are particularly suitable in applications with very high requirements concerning shape stability and constancy of the crosswise thickness profile of the streams, in particular in multi-layered headboxes.

[0008] Until now, all materials known and used for lamellae for use in headboxes for producing a material web, such as a paper or cardboard web, by at least one fibrous stock suspension, have had in common the fact that they render the lamellae sensitive to the influence of mechanical forces, such as, e.g., during handling. Furthermore, they have a low resistance to high temperatures and alkaline solutions during cleaning of the headbox by "boil out." Additionally, the service life of the lamellae is reduced due to the cited properties of the materials mentioned above.

SUMMARY OF THE INVENTION

[0009] Therefore, the present invention provides a headbox of the type generally discussed at the outset in which a lamella is provided with a better expense/effectiveness ratio for all possible utilizations and better withstands different operating conditions.

[0010] Accordingly, the present invention is directed to a headbox that includes a lamella constructed of at least one high-performance polymer, having high stability, high heat resistance, and good to very good resistance to alkaline solutions and/or acids.

[0011] High-performance polymers belong to the thermoplastic plastics, called "thermoplastics," for short, and are characterized by a very high maximum operational temperature according to UL 746 B (U.S. testing regulations of the Underwriters' Laboratories) and/or IEC 216, among other things, being in the range of about 160°C to about 260°C, i.e., which exhibits a very good heat resistance, a good to very good resistance to alkaline solutions, and increased stability values.

[0012] Due to these characteristics (mechanic, thermal, and chemical), mentioned as examples, high-performance polymers are quite optimally suitable for use as the material for lamellae. They have an improved expense/effectiveness ratio and are able to withstand worsened operating conditions for longer.

[0013] In order to increase the mechanical characteristics of the lamella and to reduce its sensitivity to the influence of mechanical forces, the high-performance polymer has a tensile strength R_m (DIN 53455) in the range of about 50 N/mm² to about 150 N/mm², preferably about 70 N/mm² to about 110 N/mm², and a breaking elongation A_5 (DIN 53455) in the range of about 20 % to about 80 %, preferably about 30 % to about 60 %. Furthermore, the high-performance polymer has a modulus of elasticity module E (DIN 53457, ISO 527-2) in the range of about 500 N/mm² to about 10,000 N/mm², preferably about 1,000 N/mm² to about 5,000 N/mm².

[0014] The connection between the lamella and the turbulence generator may be constructed in a smaller fashion, if the high-performance polymer has an impact strength when notched (ISO 179) of about 40 kJ/m² to about 100 kJ/m², preferably about 45 kJ/m² to about 90 kJ/m².

[0015] The behavior of the lamella concerning moisture and water (hydrolysis resistance) is decisively improved if the high-performance polymer has a moisture acceptance FA (ISO 62) in the range of about 0.05 % to about 2 %, preferably about 0.2 % to about 1.2 %.

[0016] In order to allow an efficient and inexpensive cleaning of a lamella, the high-performance polymer has a heat resistance WB (DIN 53461) in the range of about 120°C to about 230°C, preferably about 170°C to about 220°C, and a good to very good resistance to alkaline solutions. With these values, the performance of cleaning the headbox by "boil out" is possible, i.e., the presence of temperatures in the range of about 100°C and, simultaneously, the use of sodium hydroxide (NaOH) of about 20%.

[0017] In order to ensure the dimensional stability even during operation, the high-performance polymer has a low swelling Q, in particular, a low linear swelling Q_L, in the preferred range of about 0.02 % to about 0.2 %.

64 [0018] Out of the group of high-performance polymers that perform the above-mentioned requirements during operation and during cleaning of the headbox in an excellent fashion, polyphenylene sulphone (PPSU), polyether sulphone (PES), polyetherimide (PEI), and polysulphone (PSU) are recommended. The first three mentioned high-performance polymers were not developed until most recently.

[0019] Depending on the use in question, the lamella reaching to the region of the nozzle may, on its structure less end region viewed in the flow direction, have a dull lamella end having a height less than about 0.4 mm, preferably less than about 0.3 mm, or have on its structured end region viewed in the flow direction, a dull lamella end having a height of more than about 0.5 mm. In another embodiment, a structured end region can be provided with a grooved structure having a rectangular and/or wedge-like and/or parabolic and/or round shape with a constant and/or varying depth.

[0020] In an advantageous embodiment, the lamella is completely constructed of one high-performance polymer in a homogenous design; in an alternative embodiment, the lamella end only is formed from at least one high-performance

polymer. Thus, both embodiments ensure that at least the critical region of the lamella, i.e., the lamella end in the preferred embodiment of a lamella tip, has the advantageous characteristics of the high-performance polymer.

[0021] Furthermore, the lamella according to the invention may be embodied in a headbox with sectioned stock density control (dilution water technology). In this embodiment of the headbox, the possibility is created of allowing the sectional control of throughput, stock density, and, thus, basis weight and orientation of the fibers in the presence of the optimized lamellae.

[0022] In order to take into account present and future requirements of production with regard to the production amount, the headbox may be designed for a flow speed greater than about 1,500 m/s, preferably greater than about 1,800 m/s.

[0023] The lamella may also be integrated in a headbox embodied as a multi-layered headbox with the lamella essentially having the above-mentioned characteristics, embodied as a separating lamella of a multi-layered headbox.

[0024] It must be understood that the characteristics of the invention mentioned above and to be explained below can be used not only in the combinations mentioned, but also in different combinations or alone without departing from the scope of the invention.

[0025] The present invention is directed a lamella positionable in a headbox of a web production machine. The lamella is formed of at least one high-performance polymer; and the at least one high-performance polymer may include high stability, high heat resistance, and good to very good resistance to at least one of alkaline solution and acid.

[0026] In accordance with a feature of the present invention, the web production machine can include one of a paper, cardboard and tissue machine.

[0027] The high-performance polymer may have a tensile strength R_m (DIN

53455) in the range of about 50 N/mm² to about 150 N/mm², and a breaking elongation A_5 (DIN 53455) in the range of about 20 % to about 80 %. The tensile strength R_m can be in a range of about 70 N/mm² to about 110 N/mm², and the breaking elongation A_5 is in a range of about 30 % to 60 %.

[0028] The high-performance polymer can have a modulus of elasticity E (DIN 53457, ISO 527-2) in a range of about 500 N/mm² to about 10,000 N/mm². The modulus of elasticity E can be in a range of about 1,000 N/mm² to about 5,000 N/mm².

[0029] The high-performance polymer may have an impact strength when notched (ISO 179) of about 40 kJ/m² to about 100 kJ/m². The impact strength can be in a range of about 45 kJ/m² to about 90 kJ/m².

[0030] The high-performance polymer can have a moisture acceptance FA (ISO 62) in the range of about 0.05 % to about 2 %. The moisture acceptance FA may be in a range of about 0.2 % to about 1.2 %.

[0031] The high-performance polymer may have a heat resistance WB (DIN 53461) in the range of about 120°C to about 230°C. The heat resistance WB can be in a range of about 170°C to about 220°C.

[0032] The high-performance polymer may have a low swelling Q in a range of about 0.02 % to about 0.2 %. The low swelling Q can be a low linear swelling Q_L .

[0033] According to another feature of the invention, the high-performance polymer comprises at least one of polyphenylene sulphone (PPSU), polyether sulphone (PES), polyetherimide (PEI), and polysulphone (PSU).

[0034] Further, the headbox can include a nozzle, and the lamella may include a free end arranged to extend to a region of the nozzle. The free end may include an structure less end region with a dull lamella end having a height less than about 0.4 mm. The height of the dull lamella end can be less than about 0.3 mm.

[0035] According to still another feature of the present invention, the headbox can include a nozzle, and the lamella may include a free end arranged to extend to a region of the nozzle. The free end may include a structured end region with a dull lamella end having a height of more than about 0.5 mm. The structured end region can include grooves having at least one of (A) at least one of essentially rectangular, wedge-shaped, parabolic, and essentially round structure, and (B) varying depth. At least the lamella end can be constructed of the at least one high-performance polymer.

[0036] The lamella may be constructed of the high-performance polymer in a homogenous structure.

[0037] Further, the headbox may include a sectioned fiber suspension density control (dilution control).

[0038] According to another feature of the instant invention, the headbox can be designed for a flow speed greater than about 1,500 m/s, and preferably the flow speed may be greater than about 1,800 m/s.

[0039] Moreover, the lamella can be arranged as a separating lamella in a multi-layered headbox.

[0040] In accordance with still another feature of the invention, the lamella can be provided in combination with a headbox with a sectioned fiber suspension density control. The lamella may be located within the headbox.

[0041] Further, the lamella may be in combination with a headbox designed for a jet speed greater than about 1,500 m/s, and, preferably, the jet speed is greater than about 1,800 m/s.

[0042] In accordance with still yet another feature of the present invention, the lamella may be in combination with a multi-layered headbox. The lamella can be integrated into the multi-layered headbox as a separating lamella.

[0043] According to yet another feature of the instant invention, the web

production machine can include one of a paper, cardboard, and tissue machine.

[0044] The present invention is directed to a headbox of a web production machine. The headbox includes a lamella formed of at least one high-performance polymer. The at least one high-performance polymer includes high stability, high heat resistance, and good to very good resistance to at least one of alkaline solution and acid

[0045] Other exemplary embodiments and advantages of the present invention may be ascertained by reviewing the present disclosure and the accompanying drawing.

BRIEF DESCRIPTION OF THE DRAWINGS

[0046] The present invention is further described in the detailed description which follows, in reference to the noted plurality of drawings by way of non-limiting examples of exemplary embodiments of the present invention, in which like reference numerals represent similar parts throughout the several views of the drawings, and wherein:

[0047] Figure 1 schematically illustrates a longitudinal sectional view of a headbox having two lamellae according to the invention;

[0048] Figure 2 schematically illustrates a perspective view of a multi-layered headbox having a lamella according to the invention;

[0049] Figure 3a schematically illustrates a longitudinal sectional view of an end region of a lamella according to the invention; and

[0050] Figure 3b schematically illustrates top views from a direction IIIB depicted in Figure 3a of various structured end regions of lamellae according to the invention.

DETAILED DESCRIPTION OF THE PRESENT INVENTION

[0051] The particulars shown herein are by way of example and for purposes

of illustrative discussion of the embodiments of the present invention only and are presented in the cause of providing what is believed to be the most useful and readily understood description of the principles and conceptual aspects of the present invention. In this regard, no attempt is made to show structural details of the present invention in more detail than is necessary for the fundamental understanding of the present invention, the description taken with the drawings making apparent to those skilled in the art how the several forms of the present invention may be embodied in practice.

[0052] Figure 1 schematically illustrates a sectional view of a headbox 1, which includes a feeding device 2 for feeding a fibrous stock suspension 3. Feeding device 2 is embodied or formed as a crosswise dispersing pipe 4, however, it may include a central disperser having feeding pipes as well. Headbox 1 is further provided with a device for producing micro-turbulences (i.e., a "turbulence generator") 5 across a width of the machine, with a pre-chamber 6 arranged across the width of the machine, and arranged upstream, relative to a flow direction S (arrow), of the fibrous stock suspension 3. Accordingly, turbulence generator 5 can include a multitude of lines and columns next to one another and variously structured turbulence pipes 5.2 positioned above one another. In flow direction S (arrow) of fibrous stock suspension 3 downstream from turbulence generator 5, a nozzle 7 across the width of the machine is provided for dispersing fibrous stock suspension 3 between two wires (i.e., lower wire 8.1, upper wire 8.2) of a gap former 9, which is not shown in greater detail. In another embodiment, fibrous stock suspension 3 may be dispersed onto only one wire of a continuous wire or hybrid former. Two lamellae 10.1 and 10.2 across the width of the machine are provided in nozzle 7 of headbox 1.

[0053] According to the invention, the two lamellae 10.1 and 10.2 are constructed of at least one high-performance polymer 11, have high stability, high

heat resistance, and good to very good resistance to alkaline solutions and/or acids.

[0054] High-performance polymer 11 has a tensile strength R_m (DIN 53455) in the range of about 50 N/mm² to about 150 N/mm², preferably about 70 N/mm² to about 110 N/mm², and a breaking elongation A_5 (DIN 53455) in the range of about 20 % to about 80 %, preferably about 30 % to about 60 %. Furthermore, high-performance polymer 11 has a modulus of elasticity E (DIN 53457, ISO 527-2) in the range of about 500 N/mm² to about 10,000 N/mm², preferably about 1,000 N/mm² to about 5,000 N/mm².

[0055] Moreover, high-performance polymer 11 has an impact strength when notched (ISO 179) of about 40 kJ/m² to about 100 kJ/m², preferably about 45 kJ/m² to about 90 kJ/m², in order to allow the connection of lamellae 10.1 and 10.2 to turbulence generator 5 to be constructed in a smaller fashion.

[0056] In order to decisively improve the properties of lamellae 10.1 and 10.2 regarding moisture and water (hydrolysis resistance), high-performance polymer 11 has a moisture acceptance FA (ISO 62) in the range of about 0.05 % to about 2 %, preferably about 0.2 % to about 1.2 %.

[0057] Under the aspect of cleaning technology, high-performance polymer 11 of lamellae 10.1 and 10.2 has a heat resistance WB (DIN 59461) in the range of about 120°C to about 230°C, preferably about 170°C to about 220°C, and a good to very good resistance to alkaline solution, because having these values the performance of the cleaning of headbox 1 is possible by "boil out", i.e., the presence of temperatures in the range of about 100°C and, simultaneously, the use of sodium hydroxide (NaOH) of about 20%.

[0058] In order to ensure the dimensional stability of lamellae 10.1 and 10.2 during operation as well, high-performance polymer 11 has a low swelling Q , in particular a low linear swelling Q_L , preferably in the range of about 0.02% to about

0.2%.

[0059] Polyphenylene sulphone (PPSU), polyether sulphone (PES), polyetherimide (PEI), and polysulphone (PSU), which perform the given tasks in operation and during cleaning of a headbox in an excellent fashion are recommended among the group of high-performance polymers 11.

[0060] Advantageously, lamellae 10.1 and 10.2 are constructed in a homogenous design made from one high-performance polymer each. The use of different high-performance polymers is certainly possible as well.

[0061] Furthermore, it is discernible from Figure 1 that lamella 10.1, provided with a dull lamella end, is jointedly mounted at its end 12.1 to turbulence generator 5 and lamella 10.2, provided with a sharp lamella end, is mounted in a stationary manner to turbulence generator 5 by its end 12.2. However, in another embodiment the mounted lamella ends may be positioned in turbulence generator 5 as well, i.e., between two respective rows of turbulence pipes 5.2.

[0062] In order to take into account present and future requirements of production with regard to the production amount and the like, headbox 1 is designed for jet speeds v_j (arrow) greater than about 1,500 m/s, preferably greater than about 1,800 m/s, considering aspects of hydraulics and flow technology.

[0063] The perspective view of Figure 2 shows a headbox embodied as headbox 1.1 having feeding devices 2, 2.1, 2.2, which for introducing different fibrous stock suspensions 3, in a known fashion by two flow guidance walls 13.1, 13.2, 13.3, 13.4, 13.5, 13.6, 13.7, 13.8, 13.9, 13.10, 13.11, 13.12, 13.13, 13.14, 13.15, 13.16, 13.17, 13.18, 13.19, 13.20, 13.21, 13.22, 13.23, 13.24, 13.25, 13.26, 13.27, 13.28, 13.29, 13.30, 13.31, 13.32, 13.33, 13.34, 13.35, 13.36, 13.37, 13.38, 13.39, 13.40, 13.41, 13.42, 13.43, 13.44, 13.45, 13.46, 13.47, 13.48, 13.49, 13.50, 13.51, 13.52, 13.53, 13.54, 13.55, 13.56, 13.57, 13.58, 13.59, 13.60, 13.61, 13.62, 13.63, 13.64, 13.65, 13.66, 13.67, 13.68, 13.69, 13.70, 13.71, 13.72, 13.73, 13.74, 13.75, 13.76, 13.77, 13.78, 13.79, 13.80, 13.81, 13.82, 13.83, 13.84, 13.85, 13.86, 13.87, 13.88, 13.89, 13.90, 13.91, 13.92, 13.93, 13.94, 13.95, 13.96, 13.97, 13.98, 13.99, 14.00, 14.01, 14.02, 14.03, 14.04, 14.05, 14.06, 14.07, 14.08, 14.09, 14.10, 14.11, 14.12, 14.13, 14.14, 14.15, 14.16, 14.17, 14.18, 14.19, 14.20, 14.21, 14.22, 14.23, 14.24, 14.25, 14.26, 14.27, 14.28, 14.29, 14.30, 14.31, 14.32, 14.33, 14.34, 14.35, 14.36, 14.37, 14.38, 14.39, 14.40, 14.41, 14.42, 14.43, 14.44, 14.45, 14.46, 14.47, 14.48, 14.49, 14.50, 14.51, 14.52, 14.53, 14.54, 14.55, 14.56, 14.57, 14.58, 14.59, 14.60, 14.61, 14.62, 14.63, 14.64, 14.65, 14.66, 14.67, 14.68, 14.69, 14.70, 14.71, 14.72, 14.73, 14.74, 14.75, 14.76, 14.77, 14.78, 14.79, 14.80, 14.81, 14.82, 14.83, 14.84, 14.85, 14.86, 14.87, 14.88, 14.89, 14.90, 14.91, 14.92, 14.93, 14.94, 14.95, 14.96, 14.97, 14.98, 14.99, 15.00, 15.01, 15.02, 15.03, 15.04, 15.05, 15.06, 15.07, 15.08, 15.09, 15.10, 15.11, 15.12, 15.13, 15.14, 15.15, 15.16, 15.17, 15.18, 15.19, 15.20, 15.21, 15.22, 15.23, 15.24, 15.25, 15.26, 15.27, 15.28, 15.29, 15.30, 15.31, 15.32, 15.33, 15.34, 15.35, 15.36, 15.37, 15.38, 15.39, 15.40, 15.41, 15.42, 15.43, 15.44, 15.45, 15.46, 15.47, 15.48, 15.49, 15.50, 15.51, 15.52, 15.53, 15.54, 15.55, 15.56, 15.57, 15.58, 15.59, 15.60, 15.61, 15.62, 15.63, 15.64, 15.65, 15.66, 15.67, 15.68, 15.69, 15.70, 15.71, 15.72, 15.73, 15.74, 15.75, 15.76, 15.77, 15.78, 15.79, 15.80, 15.81, 15.82, 15.83, 15.84, 15.85, 15.86, 15.87, 15.88, 15.89, 15.90, 15.91, 15.92, 15.93, 15.94, 15.95, 15.96, 15.97, 15.98, 15.99, 16.00, 16.01, 16.02, 16.03, 16.04, 16.05, 16.06, 16.07, 16.08, 16.09, 16.10, 16.11, 16.12, 16.13, 16.14, 16.15, 16.16, 16.17, 16.18, 16.19, 16.20, 16.21, 16.22, 16.23, 16.24, 16.25, 16.26, 16.27, 16.28, 16.29, 16.30, 16.31, 16.32, 16.33, 16.34, 16.35, 16.36, 16.37, 16.38, 16.39, 16.40, 16.41, 16.42, 16.43, 16.44, 16.45, 16.46, 16.47, 16.48, 16.49, 16.50, 16.51, 16.52, 16.53, 16.54, 16.55, 16.56, 16.57, 16.58, 16.59, 16.60, 16.61, 16.62, 16.63, 16.64, 16.65, 16.66, 16.67, 16.68, 16.69, 16.70, 16.71, 16.72, 16.73, 16.74, 16.75, 16.76, 16.77, 16.78, 16.79, 16.80, 16.81, 16.82, 16.83, 16.84, 16.85, 16.86, 16.87, 16.88, 16.89, 16.90, 16.91, 16.92, 16.93, 16.94, 16.95, 16.96, 16.97, 16.98, 16.99, 17.00, 17.01, 17.02, 17.03, 17.04, 17.05, 17.06, 17.07, 17.08, 17.09, 17.10, 17.11, 17.12, 17.13, 17.14, 17.15, 17.16, 17.17, 17.18, 17.19, 17.20, 17.21, 17.22, 17.23, 17.24, 17.25, 17.26, 17.27, 17.28, 17.29, 17.30, 17.31, 17.32, 17.33, 17.34, 17.35, 17.36, 17.37, 17.38, 17.39, 17.40, 17.41, 17.42, 17.43, 17.44, 17.45, 17.46, 17.47, 17.48, 17.49, 17.50, 17.51, 17.52, 17.53, 17.54, 17.55, 17.56, 17.57, 17.58, 17.59, 17.60, 17.61, 17.62, 17.63, 17.64, 17.65, 17.66, 17.67, 17.68, 17.69, 17.70, 17.71, 17.72, 17.73, 17.74, 17.75, 17.76, 17.77, 17.78, 17.79, 17.80, 17.81, 17.82, 17.83, 17.84, 17.85, 17.86, 17.87, 17.88, 17.89, 17.90, 17.91, 17.92, 17.93, 17.94, 17.95, 17.96, 17.97, 17.98, 17.99, 18.00, 18.01, 18.02, 18.03, 18.04, 18.05, 18.06, 18.07, 18.08, 18.09, 18.10, 18.11, 18.12, 18.13, 18.14, 18.15, 18.16, 18.17, 18.18, 18.19, 18.20, 18.21, 18.22, 18.23, 18.24, 18.25, 18.26, 18.27, 18.28, 18.29, 18.30, 18.31, 18.32, 18.33, 18.34, 18.35, 18.36, 18.37, 18.38, 18.39, 18.40, 18.41, 18.42, 18.43, 18.44, 18.45, 18.46, 18.47, 18.48, 18.49, 18.50, 18.51, 18.52, 18.53, 18.54, 18.55, 18.56, 18.57, 18.58, 18.59, 18.60, 18.61, 18.62, 18.63, 18.64, 18.65, 18.66, 18.67, 18.68, 18.69, 18.70, 18.71, 18.72, 18.73, 18.74, 18.75, 18.76, 18.77, 18.78, 18.79, 18.80, 18.81, 18.82, 18.83, 18.84, 18.85, 18.86, 18.87, 18.88, 18.89, 18.90, 18.91, 18.92, 18.93, 18.94, 18.95, 18.96, 18.97, 18.98, 18.99, 19.00, 19.01, 19.02, 19.03, 19.04, 19.05, 19.06, 19.07, 19.08, 19.09, 19.10, 19.11, 19.12, 19.13, 19.14, 19.15, 19.16, 19.17, 19.18, 19.19, 19.20, 19.21, 19.22, 19.23, 19.24, 19.25, 19.26, 19.27, 19.28, 19.29, 19.30, 19.31, 19.32, 19.33, 19.34, 19.35, 19.36, 19.37, 19.38, 19.39, 19.40, 19.41, 19.42, 19.43, 19.44, 19.45, 19.46, 19.47, 19.48, 19.49, 19.50, 19.51, 19.52, 19.53, 19.54, 19.55, 19.56, 19.57, 19.58, 19.59, 19.60, 19.61, 19.62, 19.63, 19.64, 19.65, 19.66, 19.67, 19.68, 19.69, 19.70, 19.71, 19.72, 19.73, 19.74, 19.75, 19.76, 19.77, 19.78, 19.79, 19.80, 19.81, 19.82, 19.83, 19.84, 19.85, 19.86, 19.87, 19.88, 19.89, 19.90, 19.91, 19.92, 19.93, 19.94, 19.95, 19.96, 19.97, 19.98, 19.99, 20.00, 20.01, 20.02, 20.03, 20.04, 20.05, 20.06, 20.07, 20.08, 20.09, 20.10, 20.11, 20.12, 20.13, 20.14, 20.15, 20.16, 20.17, 20.18, 20.19, 20.20, 20.21, 20.22, 20.23, 20.24, 20.25, 20.26, 20.27, 20.28, 20.29, 20.30, 20.31, 20.32, 20.33, 20.34, 20.35, 20.36, 20.37, 20.38, 20.39, 20.40, 20.41, 20.42, 20.43, 20.44, 20.45, 20.46, 20.47, 20.48, 20.49, 20.50, 20.51, 20.52, 20.53, 20.54, 20.55, 20.56, 20.57, 20.58, 20.59, 20.60, 20.61, 20.62, 20.63, 20.64, 20.65, 20.66, 20.67, 20.68, 20.69, 20.70, 20.71, 20.72, 20.73, 20.74, 20.75, 20.76, 20.77, 20.78, 20.79, 20.80, 20.81, 20.82, 20.83, 20.84, 20.85, 20.86, 20.87, 20.88, 20.89, 20.90, 20.91, 20.92, 20.93, 20.94, 20.95, 20.96, 20.97, 20.98, 20.99, 21.00, 21.01, 21.02, 21.03, 21.04, 21.05, 21.06, 21.07, 21.08, 21.09, 21.10, 21.11, 21.12, 21.13, 21.14, 21.15, 21.16, 21.17, 21.18, 21.19, 21.20, 21.21, 21.22, 21.23, 21.24, 21.25, 21.26, 21.27, 21.28, 21.29, 21.30, 21.31, 21.32, 21.33, 21.34, 21.35, 21.36, 21.37, 21.38, 21.39, 21.40, 21.41, 21.42, 21.43, 21.44, 21.45, 21.46, 21.47, 21.48, 21.49, 21.50, 21.51, 21.52, 21.53, 21.54, 21.55, 21.56, 21.57, 21.58, 21.59, 21.60, 21.61, 21.62, 21.63, 21.64, 21.65, 21.66, 21.67, 21.68, 21.69, 21.70, 21.71, 21.72, 21.73, 21.74, 21.75, 21.76, 21.77, 21.78, 21.79, 21.80, 21.81, 21.82, 21.83, 21.84, 21.85, 21.86, 21.87, 21.88, 21.89, 21.90, 21.91, 21.92, 21.93, 21.94, 21.95, 21.96, 21.97, 21.98, 21.99, 22.00, 22.01, 22.02, 22.03, 22.04, 22.05, 22.06, 22.07, 22.08, 22.09, 22.10, 22.11, 22.12, 22.13, 22.14, 22.15, 22.16, 22.17, 22.18, 22.19, 22.20, 22.21, 22.22, 22.23, 22.24, 22.25, 22.26, 22.27, 22.28, 22.29, 22.30, 22.31, 22.32, 22.33, 22.34, 22.35, 22.36, 22.37, 22.38, 22.39, 22.40, 22.41, 22.42, 22.43, 22.44, 22.45, 22.46, 22.47, 22.48, 22.49, 22.50, 22.51, 22.52, 22.53, 22.54, 22.55, 22.56, 22.57, 22.58, 22.59, 22.60, 22.61, 22.62, 22.63, 22.64, 22.65, 22.66, 22.67, 22.68, 22.69, 22.70, 22.71, 22.72, 22.73, 22.74, 22.75, 22.76, 22.77, 22.78, 22.79, 22.80, 22.81, 22.82, 22.83, 22.84, 22.85, 22.86, 22.87, 22.88, 22.89, 22.90, 22.91, 22.92, 22.93, 22.94, 22.95, 22.96, 22.97, 22.98, 22.99, 23.00, 23.01, 23.02, 23.03, 23.04, 23.05, 23.06, 23.07, 23.08, 23.09, 23.10, 23.11, 23.12, 23.13, 23.14, 23.15, 23.16, 23.17, 23.18, 23.19, 23.20, 23.21, 23.22, 23.23, 23.24, 23.25, 23.26, 23.27, 23.28, 23.29, 23.30, 23.31, 23.32, 23.33, 23.34, 23.35, 23.36, 23.37, 23.38, 23.39, 23.40, 23.41, 23.42, 23.43, 23.44, 23.45, 23.46, 23.47, 23.48, 23.49, 23.50, 23.51, 23.52, 23.53, 23.54, 23.55, 23.56, 23.57, 23.58, 23.59, 23.60, 23.61, 23.62, 23.63, 23.64, 23.65, 23.66, 23.67, 23.68, 23.69, 23.70, 23.71, 23.72, 23.73, 23.74, 23.75, 23.76, 23.77, 23.78, 23.79, 23.80, 23.81, 23.82, 23.83, 23.84, 23.85, 23.86, 23.87, 23.88, 23.89, 23.90, 23.91, 23.92, 23.93, 23.94, 23.95, 23.96, 23.97, 23.98, 23.99, 24.00, 24.01, 24.02, 24.03, 24.04, 24.05, 24.06, 24.07, 24.08, 24.09, 24.10, 24.11, 24.12, 24.13, 24.14, 24.15, 24.16, 24.17, 24.18, 24.19, 24.20, 24.21, 24.22, 24.23, 24.24, 24.25, 24.26, 24.27, 24.28, 24.29, 24.30, 24.31, 24.32, 24.33, 24.34, 24.35, 24.36, 24.37, 24.38, 24.39, 24.40, 24.41, 24.42, 24.43, 24.44, 24.45, 24.46, 24.47, 24.48, 24.49, 24.50, 24.51, 24.52, 24.53, 24.54, 24.55, 24.56, 24.57, 24.58, 24.59, 24.60, 24.61, 24.62, 24.63, 24.64, 24.65, 24.66, 24.67, 24.68, 24.69, 24.70, 24.71, 24.72, 24.73, 24.74, 24.75, 24.76, 24.77, 24.78, 24.79, 24.80, 24.81, 24.82, 24.83, 24.84, 24.85, 24.86, 24.87, 24.88, 24.89, 24.90, 24.91, 24.92, 24.93, 24.94, 24.95, 24.96, 24.97, 24.98, 24.99, 25.00, 25.01, 25.02, 25.03, 25.04, 25.05, 25.06, 25.07, 25.08, 25.09, 25.10, 25.11, 25.12, 25.13, 25.14, 25.15, 25.16, 25.17, 25.18, 25.19, 25.20, 25.21, 25.22, 25.23, 25.24, 25.25, 25.26, 25.27, 25.28, 25.29, 25.30, 25.31, 25.32, 25.33, 25.34, 25.35, 25.36, 25.37, 25.38, 25.39, 25.40, 25.41, 25.42, 25.43, 25.44, 25.45, 25.46, 25.47, 25.48, 25.49, 25.50, 25.51, 25.52, 25.53, 25.54, 25.55, 25.56, 25.57, 25.58, 25.59, 25.60, 25.61, 25.62, 25.63, 25.64, 25.65, 25.66, 25.67, 25.68, 25.69, 25.70, 25.71, 25.72, 25.73, 25.74, 25.75, 25.76, 25.77, 25.78, 25.79, 25.80, 25.81, 25.82, 25.83, 25.84, 25.85, 25.86, 25.87, 25.88, 25.89, 25.90, 25.91, 25.92, 25.93, 25.94, 25.95, 25.96, 25.97, 25.98, 25.99, 26.00, 26.01, 26.02, 26.03, 26.04, 26.05, 26.06, 26.07, 26.08, 26.09, 26.10, 26.11, 26.12, 26.13, 26.14, 26.15, 26.16, 26.17, 26.18, 26.19, 26.20, 26.21, 26.22, 26.23, 26.24, 26.25, 26.26, 26.27, 26.28, 26.29, 26.30, 26.31, 26.32, 26.33, 26.34, 26.35, 26.36, 26.37, 26.38, 26.39, 26.40, 26.41, 26.42, 26.43, 26.44, 26.45, 26.46, 26.47, 26.48, 26.49, 26.50, 26.51, 26.52, 26.53, 26.54, 26.55, 26.56, 26.57, 26.58, 26.59, 26.60, 26.61, 26.62, 26.63, 26.64, 26.65, 26.66, 26.67, 26.68, 26.69, 26.70, 26.71, 26.72, 26.73, 26.74, 26.75, 26.76, 26.77, 26.78, 26.79, 26.80, 26.81, 26.82, 26.83, 26.84, 26.85, 26.86, 26.87, 26.88, 26.89, 26.90, 26.91, 26.92, 26.93, 26.94, 26.95, 26.96, 26.97, 26.98, 26.99, 27.00, 27.01, 27.02, 27.03, 27.04, 27.05, 27.06, 27.07, 27.08, 27.09, 27.10, 27.11, 27.12, 27.13, 27.14, 27.15, 27.16, 27.17, 27.18, 27.19, 27.20, 27.21, 27.22, 27.23, 27.24, 27.25, 27.26, 27.27, 27.28, 27.29, 27.30, 27.31, 27.32, 27.33, 27.34, 27.35, 27.36, 27.37, 27.38, 27.39, 27.40, 27.41, 27.42, 27.43, 27.44, 27.45, 27.46, 27.47, 27.48, 27.49, 27.50, 27.51, 27.52, 27.53, 27.54, 27.55, 27.56, 27.57, 27.58, 27.59, 27.60, 27.61, 27.62, 27.63, 27.64, 27.65, 27.66, 27.67, 27.68, 27.69, 27.70, 27.71, 27.72, 27.73, 27.74, 27.75, 27.76, 27.77, 27.78, 27.79, 27.80, 27.81, 27.82, 27.83, 27.84, 27.85, 27.86, 27.87, 27.88, 27.89, 27.90, 27.91, 27.92, 27.93, 27.94, 27.95, 27.96, 27.97, 27.98, 27.99, 28.00, 28.01, 28.02, 28.03, 28.04, 28.05, 28.06, 28.07, 28.08, 28.09, 28.10, 28.11, 28.12, 28.13, 28.14, 28.15, 28.16, 28.17, 28.18, 28.19, 28.20, 28.21, 28.22, 28.23, 28.24, 28.25, 28.26, 28.27, 28.28, 28.29, 28.30, 28.31, 28.32, 28.33, 28.34, 28.35, 28.36, 28.37, 28.38, 28.39, 28.40, 28.41, 28.42, 28.43, 28.44, 28.45, 28.46, 28.47, 28.48, 28.49, 28.50, 28.51, 28.52, 28.53, 28.54, 28.55, 28.56, 28.57, 28.58, 28.59, 28.60, 28.61, 28.62, 28.63, 28.64, 28.65, 28.66, 28.67, 28.68, 28.69, 28.70, 28.71, 28.72, 28.73, 28.74, 28.75, 28.76, 28.77, 28.78, 28.79, 28.80, 28.81, 28.82, 28.83, 28.84, 28.85, 28.86, 28.87, 28.88, 28.89, 28.90, 28.91, 28.92, 28.93, 28.94, 28.95, 28.96, 28.97, 28.98, 28.99, 29.00, 29.01, 29.02, 29.03, 29.04, 29.05, 29.06, 29.07, 29.08, 29.09, 29.10, 29.11, 29.12, 29.13, 29.14, 29.15, 29.16, 29.17, 29.18, 29.19, 29.20, 29.21, 29.22, 29.23, 29.24, 29.25, 29.26, 29.27, 29.28, 29.29, 29.30, 29.31, 29.32, 29.33, 29.34, 29.35, 29.36, 29.37, 29.38, 29.39, 29.40, 29.41, 29.42, 29.43, 29.44, 29.45, 29.46, 29.47, 29.48, 29.49, 29.50, 29.51, 29.52, 29.53, 29.54, 29.55, 29.56, 29.57, 29.58, 29.59, 29.60, 29.61, 29.62, 29.63, 29.64, 29.65, 29.66, 29.67, 29.68, 29.69, 29.70, 29.71, 29.72, 29.73, 29.74, 29.75, 29.76, 2

relative to separating wall 14.

[0064] According to the invention, multi-layered headbox 1.1 is embodied or formed as a headbox having a sectioned fibrous suspension density control (dilution water technology) as disclosed in German publication DE 40 19 593 A1, U.S. Patent No. 5,707,495, and U.S. Patent No. 5,885,420 of the Applicant, the disclosures of which are expressly incorporated by reference herein in their entireties. An initial fibrous stock suspension flow having a high consistency $Q_{H.1}$ travels via a crosswise distribution pipe 4 through a number of sectional feeding pipes $17_1 - 17_n$ branching off therefrom to turbulence generator 5. Modified from Figure 2, a volume flow control may be provided in each of the sectional feeding pipes $17_1 - 17_n$. In order to embody a sectioned stock density control the second fibrous stock suspension flow, having a lower consistency Q_L , e.g., backwater-1, is guided via a crosswise distribution pipe 4.1 and sectional feeding pipes $18_1 - 18_n$ into the sectional feeding pipes $17_1 - 17_n$. Each sectional feeding pipe $18_1 - 18_n$ has a control valve $19_1 - 19_n$ in order to feed a controlled sectional fibrous stock suspension flow Q_L to each of the corresponding merging points $20_1 - 20_n$ in which it is merged with the sectional fibrous stock suspension flow $Q_{H.1}$. A third fibrous stock suspension flow having a medium or high consistency $Q_{H.2}$ arrives at the turbulence generator 5.1 via a crosswise distribution pipe 4.2 and via a number of sectional feeding pipes $21_1 - 21_n$ branching off therefrom. Thus, in this embodiment of the multi-layered headbox 1.1, the possibility is created of allowing the sectional control of the throughput, the stock density, and thus the basis weight and the orientation of the fibers, in the presence of an optimal separation lamella 16.

[0065] The headbox 1 shown in Figure 1 may naturally also be embodied as a headbox having sectioned stock density control (dilution water technology) according to the above-mentioned embodiments.

[0066] Moreover, separating lamella 16 of multi-layered headbox 1.1 is constructed of high-performance polymer 11, having essentially the above-mentioned characteristics.

[0067] One advantage of using a high-performance polymer as the lamella material lies in the avoidance of a lamella break, even in the event of an accidental failure of the headbox pump, resulting in very high pressures between the layers in the nozzle, due to the good mechanical characteristics of the high-performance polymers.

[0068] Figure 3a shows a schematic longitudinal sectional view of an end region 22 (i.e., free end) of lamella 10.1 according to the invention.

[0069] According to the invention, lamella 10.1 is arranged to extend into a region of nozzle 7, and on its free (unmounted) end may be provided with a structure less end region 22, which provides a substantially flat (planar) surface. At the very end of end region 22, lamella 10.1 can be formed with a dull lamella end 23 having a height H of less than about 0.4 mm, preferably less than about 0.3 mm. Moreover, lamella 10.1 can be formed with a constant height h (shown in solid lines) or formed with a decreasing height h' in suspension flow direction S (shown in dot dash lines).

[0070] According to an alternative embodiment of the invention, lamella 10.1 can be arranged to extend into the region of nozzle 7, and on its free end may be provided with a structured end 22, which provides a profiled or structured surface. In this embodiment, lamella 10.1 can include a dull lamella end 23 having a height H or H' of more than about 0.5 mm in its structured free end region 22. In another embodiment, structured free end region 22 may be embodied or formed with a grooved structure 24 that is essentially rectangular and/or wedge-shaped and/or parabolic and/or essentially round with constant and/or varying depths T.

[0071] Furthermore, at least lamella end 23 may be constructed of at least one high-performance polymer 11 (dot-dashed separation line). In this regard, lamella end

23 can extend up to about 25%, and may extend up to about 50%, of a total length of lamella 10.1.

[0072] Figure 3b schematically shows three separate top views according to view arrow IIIB in Figure 3a of structured free end regions 22 of lamellae 10.1 according to the present invention.

[0073] In this regard, it is apparent that free structured end regions 22 of lamellae 10.1 according to the invention may be provided with a number of grooves 24 being essentially rectangular (A) and/or wedge-shaped (B) and/or parabolic (C) and/or essentially round with a constant and/or varying depth.

[0074] The applicant is aware of other combinations with regard to the embodiment of the free structured end region from the German Publication DE 43 29 810 A1 and U.S. Patent No. 5,639,352, the disclosures of which are expressly incorporated by reference herein in their entireties.

[0075] In conclusion it should be stated that, according to the invention, a headbox of the type mentioned at the outset is created whose lamellae have a better expense/effectiveness ratio for all kinds of possible uses and also better withstand the different operating conditions.

[0076] It is noted that the foregoing examples have been provided merely for the purpose of explanation and are in no way to be construed as limiting of the present invention. While the present invention has been described with reference to an exemplary embodiment, it is understood that the words which have been used herein are words of description and illustration, rather than words of limitation. Changes may be made, within the purview of the appended claims, as presently stated and as amended, without departing from the scope and spirit of the present invention in its aspects. Although the present invention has been described herein with reference to particular means, materials and embodiments, the present invention is not intended

P21325.S03

to be limited to the particulars disclosed herein, rather, the present invention extends to all functionally equivalent structures, methods and uses, such as are within the scope of the appended claims.

11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60
61
62
63
64
65
66
67
68
69
70
71
72
73
74
75
76
77
78
79
80
81
82
83
84
85
86
87
88
89
90
91
92
93
94
95
96
97
98
99
100
101
102
103
104
105
106
107
108
109
110
111
112
113
114
115
116
117
118
119
120
121
122
123
124
125
126
127
128
129
130
131
132
133
134
135
136
137
138
139
140
141
142
143
144
145
146
147
148
149
150
151
152
153
154
155
156
157
158
159
160
161
162
163
164
165
166
167
168
169
170
171
172
173
174
175
176
177
178
179
180
181
182
183
184
185
186
187
188
189
190
191
192
193
194
195
196
197
198
199
200
201
202
203
204
205
206
207
208
209
210
211
212
213
214
215
216
217
218
219
220
221
222
223
224
225
226
227
228
229
230
231
232
233
234
235
236
237
238
239
240
241
242
243
244
245
246
247
248
249
250
251
252
253
254
255
256
257
258
259
260
261
262
263
264
265
266
267
268
269
270
271
272
273
274
275
276
277
278
279
280
281
282
283
284
285
286
287
288
289
290
291
292
293
294
295
296
297
298
299
300
301
302
303
304
305
306
307
308
309
310
311
312
313
314
315
316
317
318
319
320
321
322
323
324
325
326
327
328
329
330
331
332
333
334
335
336
337
338
339
340
341
342
343
344
345
346
347
348
349
350
351
352
353
354
355
356
357
358
359
360
361
362
363
364
365
366
367
368
369
370
371
372
373
374
375
376
377
378
379
380
381
382
383
384
385
386
387
388
389
390
391
392
393
394
395
396
397
398
399
400
401
402
403
404
405
406
407
408
409
410
411
412
413
414
415
416
417
418
419
420
421
422
423
424
425
426
427
428
429
430
431
432
433
434
435
436
437
438
439
440
441
442
443
444
445
446
447
448
449
450
451
452
453
454
455
456
457
458
459
460
461
462
463
464
465
466
467
468
469
470
471
472
473
474
475
476
477
478
479
480
481
482
483
484
485
486
487
488
489
490
491
492
493
494
495
496
497
498
499
500
501
502
503
504
505
506
507
508
509
510
511
512
513
514
515
516
517
518
519
520
521
522
523
524
525
526
527
528
529
530
531
532
533
534
535
536
537
538
539
540
541
542
543
544
545
546
547
548
549
550
551
552
553
554
555
556
557
558
559
560
561
562
563
564
565
566
567
568
569
570
571
572
573
574
575
576
577
578
579
580
581
582
583
584
585
586
587
588
589
590
591
592
593
594
595
596
597
598
599
600
601
602
603
604
605
606
607
608
609
610
611
612
613
614
615
616
617
618
619
620
621
622
623
624
625
626
627
628
629
630
631
632
633
634
635
636
637
638
639
640
641
642
643
644
645
646
647
648
649
650
651
652
653
654
655
656
657
658
659
660
661
662
663
664
665
666
667
668
669
670
671
672
673
674
675
676
677
678
679
680
681
682
683
684
685
686
687
688
689
690
691
692
693
694
695
696
697
698
699
700
701
702
703
704
705
706
707
708
709
710
711
712
713
714
715
716
717
718
719
720
721
722
723
724
725
726
727
728
729
730
731
732
733
734
735
736
737
738
739
740
741
742
743
744
745
746
747
748
749
750
751
752
753
754
755
756
757
758
759
760
761
762
763
764
765
766
767
768
769
770
771
772
773
774
775
776
777
778
779
780
781
782
783
784
785
786
787
788
789
790
791
792
793
794
795
796
797
798
799
800
801
802
803
804
805
806
807
808
809
810
811
812
813
814
815
816
817
818
819
820
821
822
823
824
825
826
827
828
829
830
831
832
833
834
835
836
837
838
839
840
841
842
843
844
845
846
847
848
849
850
851
852
853
854
855
856
857
858
859
860
861
862
863
864
865
866
867
868
869
870
871
872
873
874
875
876
877
878
879
880
881
882
883
884
885
886
887
888
889
890
891
892
893
894
895
896
897
898
899
900
901
902
903
904
905
906
907
908
909
910
911
912
913
914
915
916
917
918
919
920
921
922
923
924
925
926
927
928
929
930
931
932
933
934
935
936
937
938
939
940
941
942
943
944
945
946
947
948
949
950
951
952
953
954
955
956
957
958
959
960
961
962
963
964
965
966
967
968
969
970
971
972
973
974
975
976
977
978
979
980
981
982
983
984
985
986
987
988
989
990
991
992
993
994
995
996
997
998
999
1000
1001
1002
1003
1004
1005
1006
1007
1008
1009
1010
1011
1012
1013
1014
1015
1016
1017
1018
1019
1020
1021
1022
1023
1024
1025
1026
1027
1028
1029
1030
1031
1032
1033
1034
1035
1036
1037
1038
1039
1040
1041
1042
1043
1044
1045
1046
1047
1048
1049
1050
1051
1052
1053
1054
1055
1056
1057
1058
1059
1060
1061
1062
1063
1064
1065
1066
1067
1068
1069
1070
1071
1072
1073
1074
1075
1076
1077
1078
1079
1080
1081
1082
1083
1084
1085
1086
1087
1088
1089
1090
1091
1092
1093
1094
1095
1096
1097
1098
1099
1100
1101
1102
1103
1104
1105
1106
1107
1108
1109
1110
1111
1112
1113
1114
1115
1116
1117
1118
1119
1120
1121
1122
1123
1124
1125
1126
1127
1128
1129
1130
1131
1132
1133
1134
1135
1136
1137
1138
1139
1140
1141
1142
1143
1144
1145
1146
1147
1148
1149
1150
1151
1152
1153
1154
1155
1156
1157
1158
1159
1160
1161
1162
1163
1164
1165
1166
1167
1168
1169
1170
1171
1172
1173
1174
1175
1176
1177
1178
1179
1180
1181
1182
1183
1184
1185
1186
1187
1188
1189
1190
1191
1192
1193
1194
1195
1196
1197
1198
1199
1200
1201
1202
1203
1204
1205
1206
1207
1208
1209
1210
1211
1212
1213
1214
1215
1216
1217
1218
1219
1220
1221
1222
1223
1224
1225
1226
1227
1228
1229
1230
1231
1232
1233
1234
1235
1236
1237
1238
1239
1240
1241
1242
1243
1244
1245
1246
1247
1248
1249
1250
1251
1252
1253
1254
1255
1256
1257
1258
1259
1260
1261
1262
1263
1264
1265
1266
1267
1268
1269
1270
1271
1272
1273
1274
1275
1276
1277
1278
1279
1280
1281
1282
1283
1284
1285
1286
1287
1288
1289
1290
1291
1292
1293
1294
1295
1296
1297
1298
1299
1300
1301
1302
1303
1304
1305
1306
1307
1308
1309
1310
1311
1312
1313
1314
1315
1316
1317
1318
1319
1320
1321
1322
1323
1324
1325
1326
1327
1328
1329
1330
1331
1332
1333
1334
1335
1336
1337
1338
1339
1340
1341
1342
1343
1344
1345
1346
1347
1348
1349
1350
1351
1352
1353
1354
1355
1356
1357
1358
1359
1360
1361
1362
1363
1364
1365
1366
1367
1368
1369
1370
1371
1372
1373
1374
1375
1376
1377
1378
1379
1380
1381
1382
1383
1384
1385
1386
1387
1388
1389
1390
1391
1392
1393
1394
1395
1396
1397
1398
1399
1400
1401
1402
1403
1404
1405
1406
1407
1408
1409
1410
1411
1412
1413
1414
1415
1416
1417
1418
1419
1420
1421
1422
1423
1424
1425
1426
1427
1428
1429
1430
1431
1432
1433
1434
1435
1436
1437
1438
1439
1440
1441
1442
1443
1444
1445
1446
1447
1448
1449
1450
1451
1452
1453
1454
1455
1456
1457
1458
1459
1460
1461
1462
1463
1464
1465
1466
1467
1468
1469
1470
1471
1472
1473
1474
1475
1476
1477
1478
1479
1480
1481
1482
1483
1484
1485
1486
1487
1488
1489
1490
1491
1492
1493
1494
1495
1496
1497
1498
1499
1500
1501
1502
1503
1504
1505
1506
1507
1508
1509
1510
1511
1512
1513
1514
1515
1516
1517
1518
1519
1520
1521
1522
1523
1524
1525
1526
1527
1528
1529
1530
1531
1532
1533
1534
1535
1536
1537
1538
1539
1540
1541
1542
1543
1544
1545
1546
1547
1548
1549
1550
1551
1552
1553
1554
1555
1556
1557
1558
1559
1560
1561
1562
1563
1564
1565
1566
1567
1568
1569
1570
1571
1572
1573
1574
1575
1576
1577
1578
1579
1580
1581
1582
1583
1584
1585
1586
1587
1588
1589
1590
1591
1592
1593
1594
1595
1596
1597
1598
1599
1600
1601
1602
1603
1604
1605
1606
1607
1608
1609
1610
1611
1612
1613
1614
1615
1616
1617
1618
1619
1620
1621
1622
1623
1624
1625
1626
1627
1628
1629
1630
1631
1632
1633
1634
1635
1636
1637
1638
1639
1640
1641
1642
1643
1644
1645
1646
1647
1648
1649
1650
1651
1652
1653
1654
1655
1656
1657
1658
1659
1660
1661
1662
1663
1664
1665
1666
1667
1668
1669
1670
1671
1672
1673
1674
1675
1676
1677
1678
1679
1680
1681
1682
1683
1684
1685
1686
1687
1688
1689
1690
1691
1692
1693
1694
1695
1696
1697
1698
1699
1700
1701
1702
1703
1704
1705
1706
1707
1708
1709
1710
1711
1712
1713
1714
1715
1716
1717
1718
1719
1720
1721
1722
1723
1724
1725
1726
1727
1728
1729
1730
1731
1732
1733
1734
1735
1736
1737
1738
1739
1740
1741
1742
1743
1744
1745
1746
1747
1748
1749
1750
1751
1752
1753
1754
1755
1756
1757
1758
1759
1760
1761
1762
1763
1764
1765
1766
1767
1768
1769
1770
1771
1772
1773
1774
1775
1776
1777
1778
1779
1780
1781
1782
1783
1784
1785
1786
1787
1788
1789
1790
1791
1792
1793
1794
1795
1796
1797
1798
1799
1800
1801
1802
1803
1804
1805
1806
1807
1808
1809
1810
1811
1812
1813
1814
1815
1816
1817
1818
1819
1820
1821
1822
1823
1824
1825
1826
1827
1828
1829
1830
1831
1832
1833
1834
1835
1836
1837
1838
1839
1840
1841
1842
1843
1844
1845
1846
1847
1848
1849
1850
1851
1852
1853
1854
1855
1856
1857
1858
1859
1860
1861
1862
1863
1864
1865
1866
1867
1868
1869
1870
1871
1872
1873
1874
1875
1876
1877
1878
1879
1880
1881
1882
1883
1884
1885
1886
1887
1888
1889
1890
1891
1892
1893
1894
1895
1896
1897
1898
1899
1900
1901
1902
1903
1904
1905
1906
1907
1908
1909
1910
1911
1912
1913
1914
1915
1916
1917
1918
1919
1920
1921
1922
1923
1924
1925
1926
1927
1928
1929
1930
1931
1932
1933
1934
1935
1936
1937
1938
1939
1940
1941
1942
1943
1944
1945
1946
1947
1948
1949
1950
1951
1952
1953
1954
1955
1956
1957
1958
1959
1960
1961
1962
1963
1964
1965
1966
1967
1968
1969
1970
1971
1972
1973
1974
1975
1976
1977
1978
1979
1980
1981
1982
1983
1984
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
2026
2027
2028
2029
2030
2031
2032
2033
2034
2035
2036
2037
2038
2039
2040
2041
2042
2043
2044
2045
2046
2047
2048
2049
2050
2051
2052
2053
2054
2055
2056
2057
2058
2059
2060
2061
2062
2063
2064
2065
2066
2067
2068
2069
2070
2071
2072
2073
2074
2075
2076
2077
2078
2079
2080
2081
2082
2083
2084
2085
2086
2087
2088
2089
2090
2091
2092
2093
2094
2095
2096
2097
2098
2099
2100
2101
2102
2103
2104
2105
2106
2107
2108
2109
2110
2111
2112
2113
2114
2115
2116
2117
2118
2119
2120
2121
2122
2123
2124
2125
2126
2127
2128
2129
2130
2131
2132
2133
2134
2135
2136
2137
2138
2139
2140
2141
2142
2143
2144
2145
2146
2147
2148
2149
2150
2151
2152
2153
2154
2155
2156
2157
2158
2159
2160
2161
2162
2163
2164
2165
2166
2167
2168
2169
2170
2171
2172
2173
2174
2175
2176
2177
2178
2179
2180
2181
2182
2183
2184
2185
2186
2187
2188
2189
2190
2191
2192
2193
2194
2195
2196
2197
2198
2199
2200
2201
2202
2203
2204
2205
2206
2207
2208
2209
2210
2211
2212
2213
2214
2215
2216
2217
2218
2219
2220
2221
2222
2223
2224
2225
2226
2227
2228
2229
2230
2231

LIST OF REFERENCE CHARACTERS

| | |
|-----------------------------------|--|
| 1 | headbox |
| 1.1 | multi-layered headbox |
| 2, 2.1, 2.2 | feeding device |
| 3, 3.1, 3.2 | fibrous stock suspension |
| 4, 4.1, 4.2 | crosswise distribution pipe |
| 5, 5.1 | turbulence generator |
| 5.2 | turbulence pipe |
| 6 | pre-chamber |
| 7 | nozzle |
| 8.1 | lower wire |
| 8.2 | upper wire |
| 9 | gap former |
| 10.1, 10.2 | lamella |
| 11 | high-performance polymer |
| 12.1, 12.2 | end |
| 13.1, 13.2 | flow guidance wall across the width of the machine |
| 14 | separating wall |
| 15 | joint |
| 16 | separating lamella |
| 17 ₁ - 17 _n | sectional feeding pipe |
| 18 ₁ - 18 _n | sectional feeding pipe |
| 19 ₁ - 19 _n | control valve |
| 20 ₁ - 20 _n | merging point |
| 21 ₁ - 21 _n | sectional feeding pipe |

P21325.S03

22 end region (free, unmounted end)
23 lamella end
24 groove

A, B, C top view

B view arrow

H height (constant)

H' height (decreasing)

h height (constant)

h' height (decreasing)

$Q_{H.1}$ initial fibrous stock suspension flow with a high consistency

$Q_{H.2}$ third fibrous stock suspension flow with a medium/high consistency

Q_L second fibrous stock suspension flow with a low consistency

S flow direction

T depth

v_s jet speed